



ALBERT-LUDWIGS-
UNIVERSITÄT FREIBURG

Algorithms for Radio Networks

Wireless Sensor Networks - Introduction

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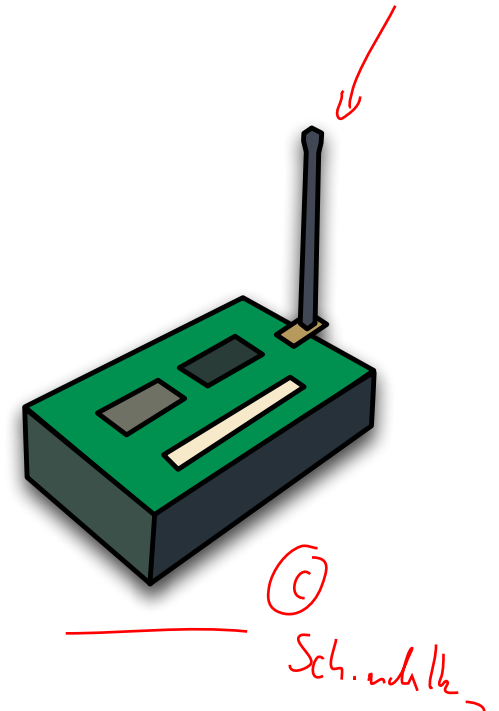
Wireless Sensor Networks (WSN)

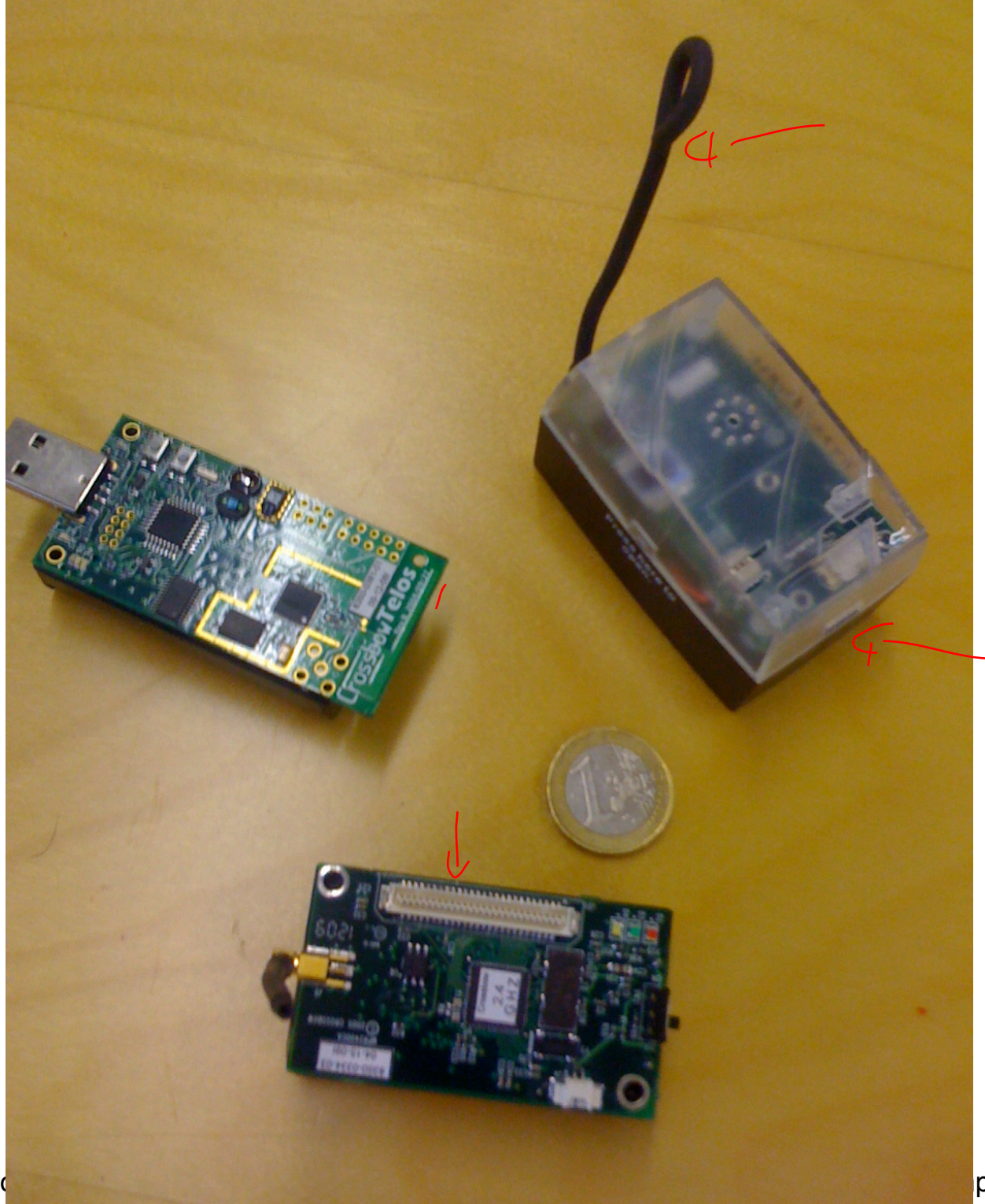
► Wireless sensor networks (WSN)

- Network embedded in an environment
 - measure and interact with the environment
- Nodes collect, process and use this information
- Wireless sensor & actuator networks (WSAN)

► WSN Nodes

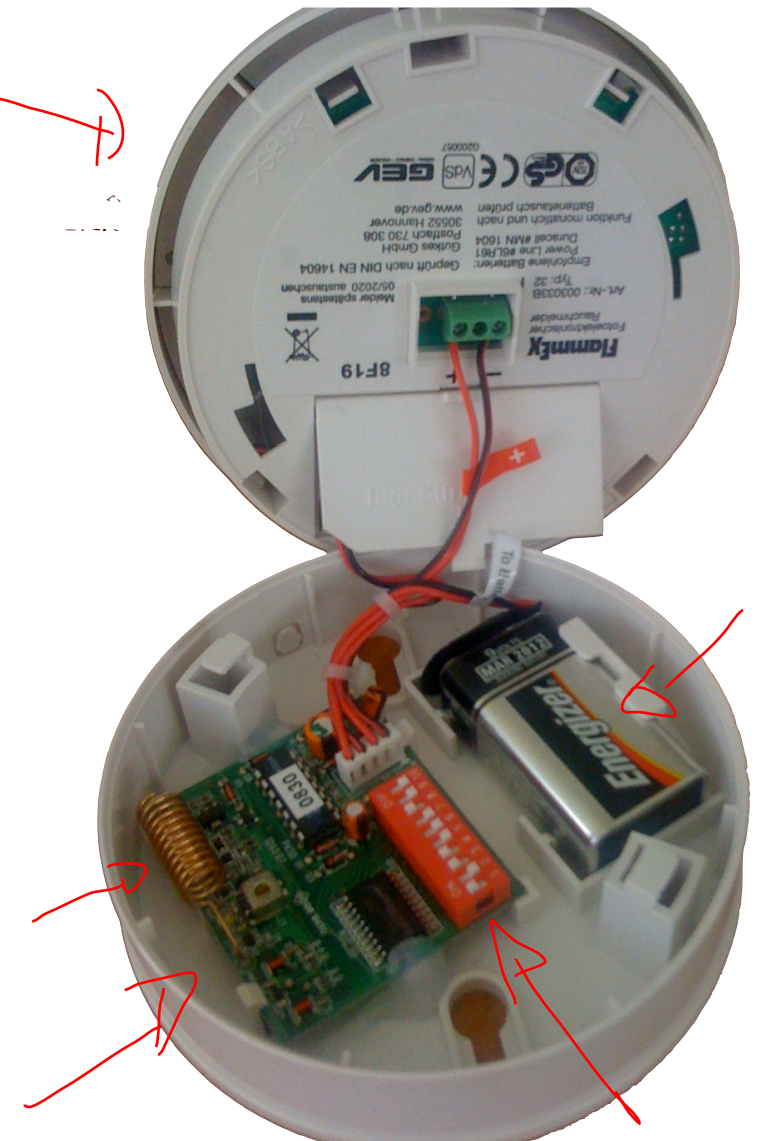
- Sensors
- Actuators
- Microprocessor
- Transceiver





Example

- ▶ **Smoke detection network**
 - Sensors:
 - smoke sensors
 - Actuators:
 - acoustic warning signal
 - Optical test signal
 - Transceiver and microprocessor
- ▶ **Alarms are activated at all connected smoke detectors**



Roles in Wireless Sensor Networks

► Data Sources

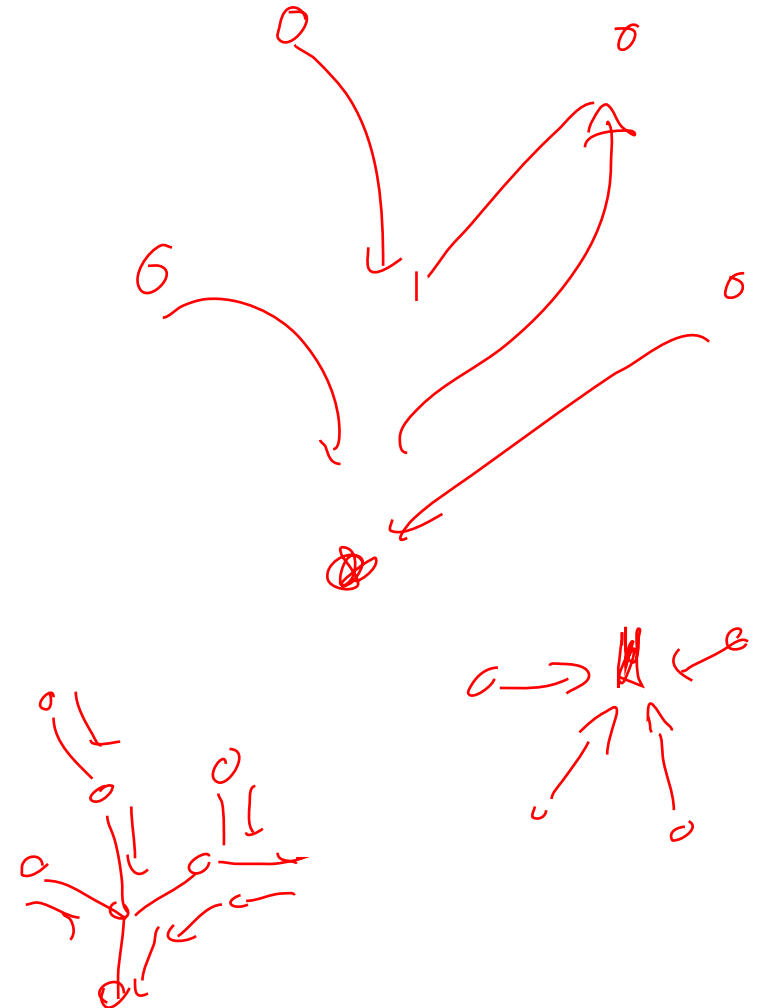
- data collection and transmission
- equipped with sensors

► Data sinks

- collects all data
- part of the WSN and external entity
 - e.g. PDA, gateway, PC, etc.

► Actuator

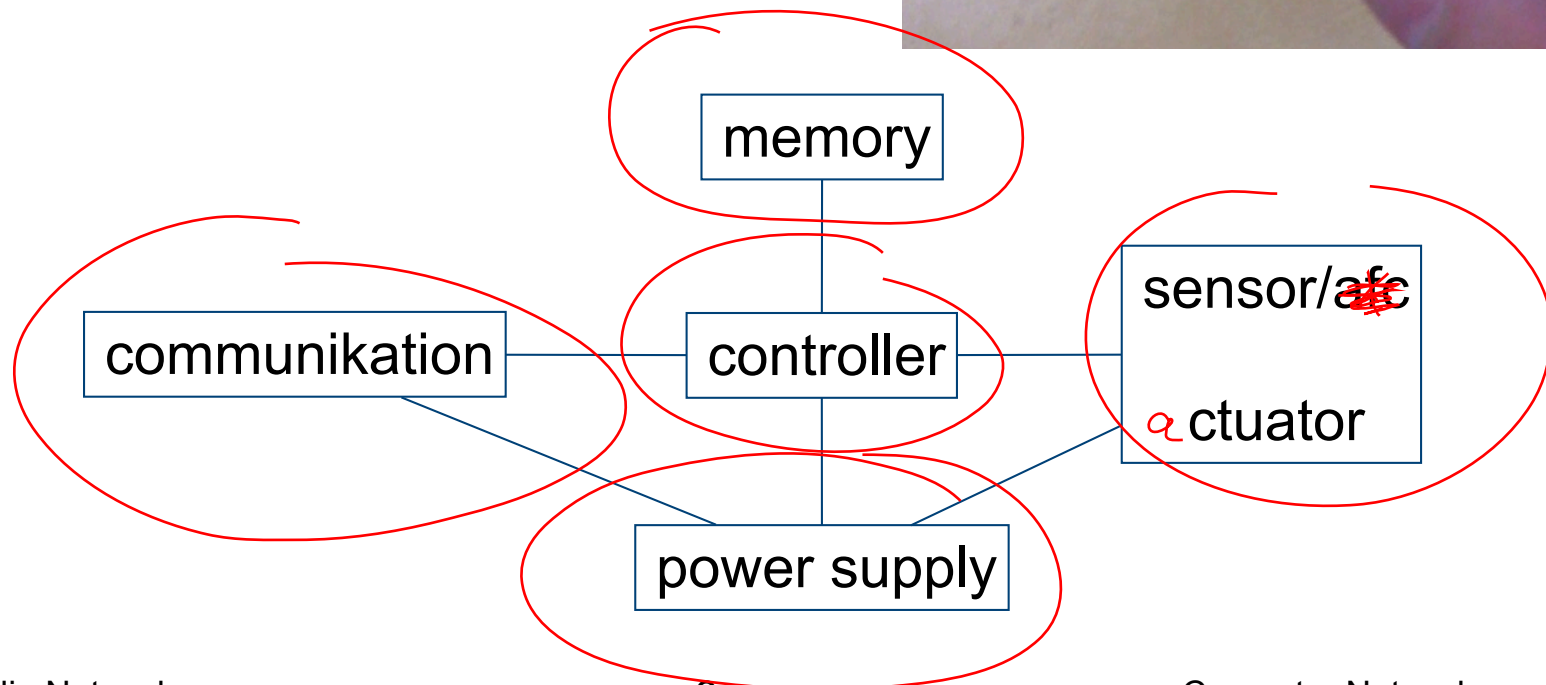
- changes the environment
- e.g. light source, speakers, engine



Architecture of a WSN Unit

► Main components of a WSN unit

- controller
- communications unit
- sensor / actuator
- memory
- power



Technologies for WSN

‣ Mass production and price reduction

- for wireless communications
- Micro-controller
- sensors
- batteries

‣ Miniaturization

- "Smart dust"

g - Joke

‣ Energy harvesting

- power supply from the environment
- e.g. Light, heat, motion, chemical

Controller

► Types

- Microcontroller

- microprocessor for embedded applications

- low power consumption

- inexpensive

- FPGA (Field Programmable Gate Array)

- too high power consumption

- ASIC (Application Specific Integrated Circuit)

- special circuit design

- best but most expensive solution

Sample Configuration

- ▶ **Texas Instruments MSP430**
 - 16-bit RISC core
 - up to 4 MHz
 - 2-10 kbytes RAM
 - several analog-digital converters
- ▶ **Atmel ATmega 128L (z.B. Mica-2)**
 - 8-bit controller
 - 128 kB Flash program memory
 - 4-8 kB SRAM
 - 4-7,4 MHz

Energy efficiency

► Standard

- Power supply from batteries

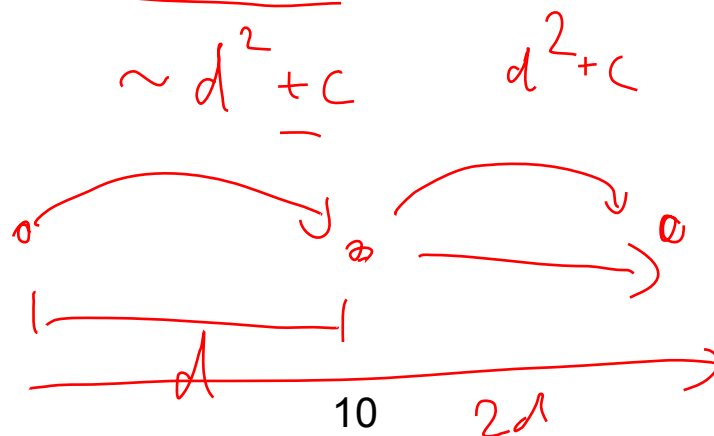
► Long run times for

- Nodes and overall network

► Necessary: energy-efficient protocols

- Multi-hop routes with low energy
- Battery capacity as a parameter for algorithms
- Energy and networking poses a conflict of interest

$$(2d)^2 + c$$



$$4d^2 + c$$

$$2d^2 + 2c$$

MANET versus WSN

► Similarities

- Self-Organization
- Energy efficiency is necessary
- Wireless multi-hop networks
- No centralized control or infrastructure

MANET versus WSN differences

► MANETs

- larger bandwidths
- computationally stronger nodes
- interconnect users (for example, to laptops, PDAs)

► WSN

- • highly application-oriented
- • interact with the environment
- • sometimes have more nodes
- • stronger requirements for energy efficiency and maintenance
- longer life time

- individual WSN nodes dispensable

► WSN

- data centric

► MANET

- ID-centric

► mobility

- sometimes in WSN much higher than in MANETs
- e.g. If mobility is measured

WSN Applications

‣ **Disaster relief**

- sensor nodes are dropped from planes over fires

‣ **Nodes measure temperature**

- online collection of fires

‣ **Biology**

- biodiversity acquisition
- sensor nodes collect wildlife
 - e.g. rare animals in remote areas
- detection of migration of animals
 - e.g. Zebras, cows, storks

WSN Applications

▶ Intelligent buildings or bridges

- Reduction of energy wastage
 - by humidity, ventilation, cooling and heating control
- Measurement of space usage, temperature, air currents ...
- Measurement of the building load to earthquakes, earth movements

▶ Environmental measurements

- e.g. measurement of the Gulf Stream, other water currents, weather balloons

WSN Application

▶ Industrial control

- building control
 - Theft, access
- leakage control in chemical plants
- plant control

▶ Machine condition monitoring and preventive control

- embedding of sensors and control units, where cables are not available
- such as tire pressure monitoring

WSN Application

▶ Automated agriculture

- fertilizer, pesticide and irrigation control
- sensors monitor the soil chemistry and soil physics

▶ Medicine and health care

- postoperative or intensive care
- long-term monitoring of chronically ill or elderly

WSN Application

‣ Logistics

- goods are equipped with sensors
- localization and Quality Control

‣ Telematics

- better traffic control through more accurate traffic monitoring

‣ Intelligent roads

- cars as traffic sensors

V2V



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